METHANE de-NOX® for Utility PC Boilers

Quarterly Technical Progress Report
for the period ending September 30, 2003

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ABSTRACT

During the current quarter, pilot-scale testing with the modified air nozzle version of the PC burner was completed with PRB coal at the Riley Power Inc. (RPI) test facility. A total of 8 different burner configurations were tested utilizing various burner air nozzle arrangements in place of the burner air channels. It was found that with the arrangements tested, a stable flame could not be maintained at coal feed rates above 100 lb/h. While it is felt that the air nozzle approach can ultimately be used effectively, in the interest of holding to the current project schedule it was decided to proceed with the balance of the project using the air channel design.

The pilot-scale PC burner was therefore restored to the air-channel configuration and benchmark testing with PRB coal to confirmed previous operating results. A series of tests was then conducted with PRB and West Virginia caking coal to evaluate modifications to the gas combustor configuration and operation for improved performance with caking coal. Continuous operation was achieved with caking coal up to 50 lb/h vs. the full load target of 150 lb/h. Impingement and deposition of partially devolatilized coal occurred at various points within the combustor when the caking coal feed was increased above 50 lb/h.

The 100 MMBtu/h commercial-scale prototype design was continued with coal burner design input from both RPI and VTI. Based on typical burner installation layout considerations, it was decided that the preheat combustor should be oriented horizontally on the axial centerline of the coal burner. Accordingly, the pilot gas combustor was changed to this orientation so that the pilot results with caking coal will be directly applicable to the preferred 100 MMBtu design. Testing with caking coal in the horizontal pilot combustor achieved feed rates up to 126 lb/h, although some deposition and LOI issues remain. Several promising approaches to further improve operation with caking coal were identified. NOx results with caking coal are promising, with NOx as low as 150 ppmv at exit oxygen levels of 4% and higher.

The 100 MMBtu/h commercial-scale prototype design is nearing completion. Design of the caking coal version of the unit continues with additional pilot testing in support of this design expected. GTI and RPI are expediting the fabrication of the 100 MMBtu/h PRB unit in order to start testing in early- to mid-December.

Inspection and repair of the 100 MMBtu/h Coal Burner Test Facility (CBTF) is nearing completion. As of mid-September, this activity was 95% complete.

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EXECUTIVE SUMMARY

Project Objectives: The overall project objective is the development and validation of an innovative combustion system, based on a novel coal preheating concept prior to combustion, that can reduce NO_x emissions to 0.15 lb/million Btu or less on utility pulverized coal (PC) boilers. This NO_x reduction should be achieved without loss of boiler efficiency or operating stability, and at more than 25% lower levelized cost than state-of-the-art SCR technology. A further objective is to make this technology ready for full-scale commercial deployment in order to meet an anticipated market demand for NO_x reduction technologies resulting from the EPA's NO_x SIP call.

Background: A novel pulverized coal-preheating approach for NO_x reduction was developed by the All Russian Thermal Engineering Institute (VTI), in Russia, for use on PC utility boilers. The approach consists of a burner modification that preheats pulverized coal to elevated temperatures (up to 1500°F) prior to coal combustion. This releases coal volatiles, including fuel-bound nitrogen compounds, into a reducing environment, which converts the coal-derived nitrogen compounds to molecular N_2. The quantity of natural gas fuel required for PC preheating is in the range of 3 to 5% of the total burner heat input. Basic combustion research and development of the preheat PC burner was conducted by VTI in the early 1980's. Following these promising laboratory results, commercial-scale PC preheating burners of 30 and 60 MW_t capacity were developed and demonstrated in field tests conducted in several Russian power stations.

The advanced PC preheating combustion system being developed in this project for direct-fired PC boilers combines the modified VTI preheat burner approach with elements of IGT's successful METHANE de-NOX technology for NO_x reduction in stoker boilers. The new PC preheating system combines several NO_x reduction strategies into an integrated system, including a novel PC burner design using natural gas-fired coal preheating, and internal and external combustion staging in the primary and secondary combustion zones.

Design, installation, shakedown and initial PRB coal testing of a 3-million Btu/h pilot system at RPI's Pilot-Scale Combustion Facility (PSCF) in Worcester, MA demonstrated that the PC Preheat process has a significant effect on final NO_x formation in the coal burner. Various modifications were made to both the pilot system gas-fired combustor and the PC burner in order to test the full potential of the process for NO_x reduction. NO_x reduction was demonstrated with PRB coal at levels below100 ppmv with CO in the range of 35-112 ppmv without any furnace air staging.

Initial pilot testing with caking coal resulted in deposition and plugging by caked material inside of the gas combustor. Modifications to the combustor configuration and operation were developed that achieved sustained operation with caking coal up to 50 lb/h vs. the full load target of 150 lb/h. The unit was then converted to a horizontal configuration for the PREHEAT combustor. Testing with PRB coal in this configuration confirmed results similar to the vertical unit. Testing of the horizontal with Central Appalachian caking coal using increased combustor velocities has resulted in operation up to 126 lb/h, although some deposition and LOI issues remain. Several promising approaches to further improve operation with caking coal were identified. NOx results with caking coal were promising, with NOx as low as 150 ppmv at exit oxygen levels of 4% and higher.

The design of the 100 MMBtu/h unit for testing with PRB coal is nearly complete. Design of the caking coal version of the unit continues with additional pilot testing in support of this design expected. GTI and RPI are expediting the fabrication of the 100 MMBtu/h PRB unit in order to start testing in early- to mid-December.

EXPERIMENTAL

Pilot Unit

Fabrication, installation and initial testing of the pilot-scale PC PREHEAT system were completed in the fall of 2001. The unit is sized for operation with natural gas and pulverized coal at a total firing rate of approximately 3-million Btu/h and includes all equipment and controls necessary to operate and monitor energy and environmental performance of the system. A gravimetric feeder is used to regulate pulverized coal flow through a rotary airlock into a natural gas-fired PREHEAT combustor. The combustor produces hot combustion gases, which combine with the pulverized coal to produce a mixture of coal char and pyrolysis products at the desired test temperature. In the original pilot system configuration, the combustor centerline was vertical and two PREHEAT pipe sections after the combustor provided additional residence time for the coal at the preheated conditions prior to entering the PC burner. However, pilot testing experience together with commercial design guidance from RPI redirected the development of both the pilot and commercial units toward a horizontal combustor design with no diameter change between the combustor and burner. During the current quarter, the PREHEAT combustor was therefore relocated to a horizontal configuration with the combustor exit coupled directly to the PC burner inlet, eliminating the two PREHEAT pipe sections. In the modified pilot unit, the velocity of the devolatilization products in the combustor and burner is increased over previous pilot testing to minimize separation and impingement of coal on inner surfaces prior to reaching the burner face. The velocities utilized are consistent with standard design criteria developed by RPI for their commercial CCV burners. The P&ID for the modified pilot system with the horizontal PREHEAT combustor is shown in Figure 1.

During testing, real time operating data are collected at 1-second intervals and recorded by the personal computer-based data acquisition system (DAS). The concentrations of CO, CO_2, O_2, THC and NO/NO_x in the PC PREHEAT unit exhaust and the furnace exit are continuously monitored by on-line gas analyzers, including a Rosemount Analytical Model 880A infrared CO analyzer, a Rosemount Analytical Model 880A infrared CO_2 analyzer, a Rosemount Model 400 flame ionization total hydrocarbons (THC) analyzer, a Rosemount Analytical Model 755R paramagnetic O_2 analyzer, and a ThermoElectron Model 14A chemiluminescence NO_x analyzer.

The PREHEAT gas combustor temperatures are monitored by thermocouples installed on both the outer walls and inside of the combustion chamber. Temperature of the gas/air mixture is monitored in the gas/air plenum entering the combustor nozzles.

100 MMBtu/h Unit

The CBTF comprises a large horizontally fired dry bottom furnace capable of testing full-scale burner systems with firing capacities up to 100 MMBtu/h. The furnace is fully integrated with coal storage, grinding and feeding, emissions control, and continuous flue gas sampling and analytical subsystems.

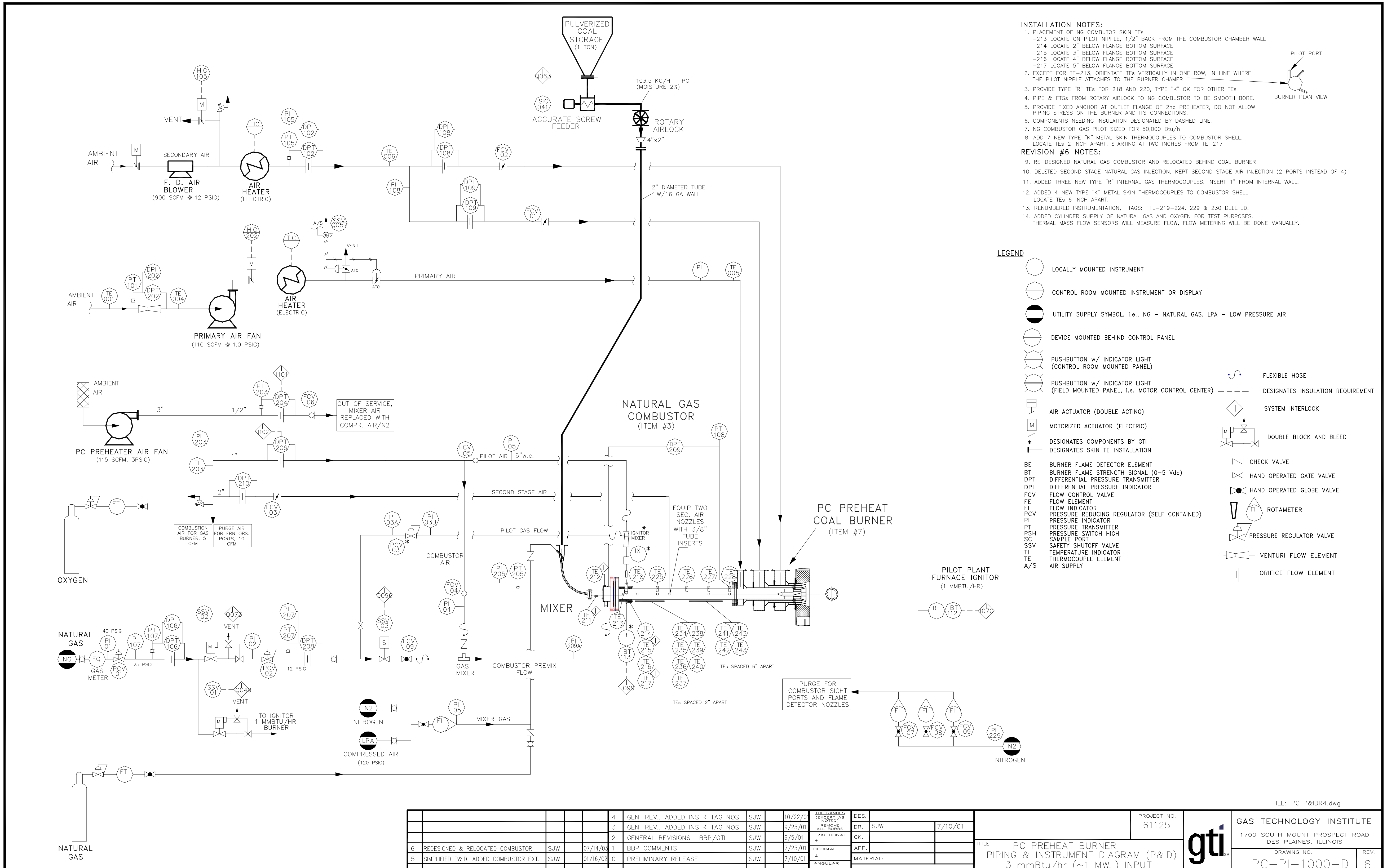

Figure 1. Process and Instrument Diagram for the modified pilot unit

A process flow diagram for the 100 MMBtu/h unit is shown in Figure 2. Coal is pulverized and dried in a DB Riley Model 350 Atrita pulverizer, which is fed from a 40-ton bunker by a weigh-belt feeder and rotary valve. The mill's air supply system includes a Venturi air flow meter, fan and natural gas direct-fired heater to supply a measured amount of hot air to the pulverizer to dry and transport the coal. The CBTF is capable of firing in both the direct fire mode and from an intermediate storage bin (indirect fire). All testing will be conducted in the direct fire mode to simulate the most common firing method in the U.S market. Drying and transport air will be separated from coal stream immediately ahead of the PC PREHEAT combustor inlet. The separated air will be directed to one of the three air channels in the coal burner. Secondary air will be preheated to 600 ºF by a separate fan and heater and routed to the coal burner. Air can be routed to the burner through an integral windbox plenum or through separate external ducts. Flow to each burner air channel can be regulated independently. Ports are also available at several locations for furnace air staging.

Flue gas composition will be monitored continuously. A multiple-probe sampling grid consisting of sintered Hasteloy filters is mounted in the CBTF exit duct, just upstream of the flue gas scrubber. The in-duct filters remove the majority of particulate, and the flue gas is drawn through stainless steel tubing, ice-bath conditioners, and a final filter by individual sample pumps. A rotameter at the outlet of each pump is used to admit equal flow of clean, dry sample from each grid probe to a manifold. The proper flow of sample for each continuous analyzer is supplied from the manifold.

Continuous monitors are used to measure O_2, CO_2, CO, NO/NO_x and SO_2. In addition to the gas sampling grid, a separate water-cooled probe is used to withdraw particulate samples at the CBTF outlet for determination of carbon burnout. A high velocity thermocouple probe monitors furnace outlet temperature.

The CBTF is fully instrumented to allow continuous measurement and recording or all relevant flow, pressure and temperature readings to allow complete material and energy balances to be developed for each testing period.

RESULTS AND DISCUSSION

Project Status:

Task 1.1 *Pilot-Scale Design*

Design drawings, including the PC burner modifications, the horizontal PREHEAT combustor details, and the overall system arrangements were developed for relocating the 3 MMBtu/h preheat combustor to a horizontal orientation. The general arrangement drawing for the modified pilot system is shown in Figure 3. Reorientation of the combustor to horizontal placement required changes in the unit's thermal expansion provisions. The thermal expansion compensator for vertical growth in the system was eliminated and a movable support was developed for the combustor to accommodate horizontal thermal expansion of the combustor. This horizontal movement is now taken as bending in the long vertical coal pipe.

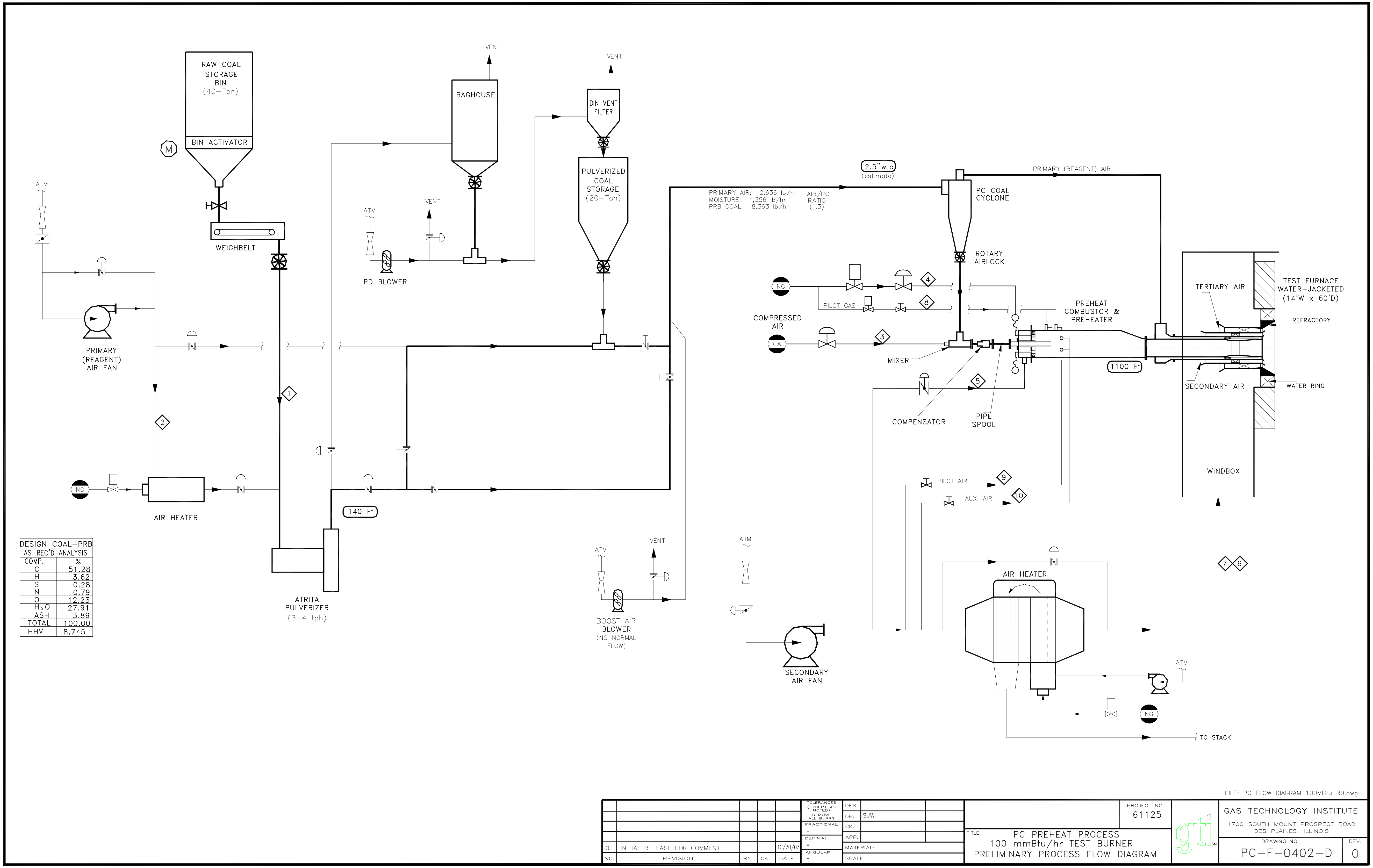

Figure 2. Process and Instrument Diagram for 100 MMBtu/h test unit

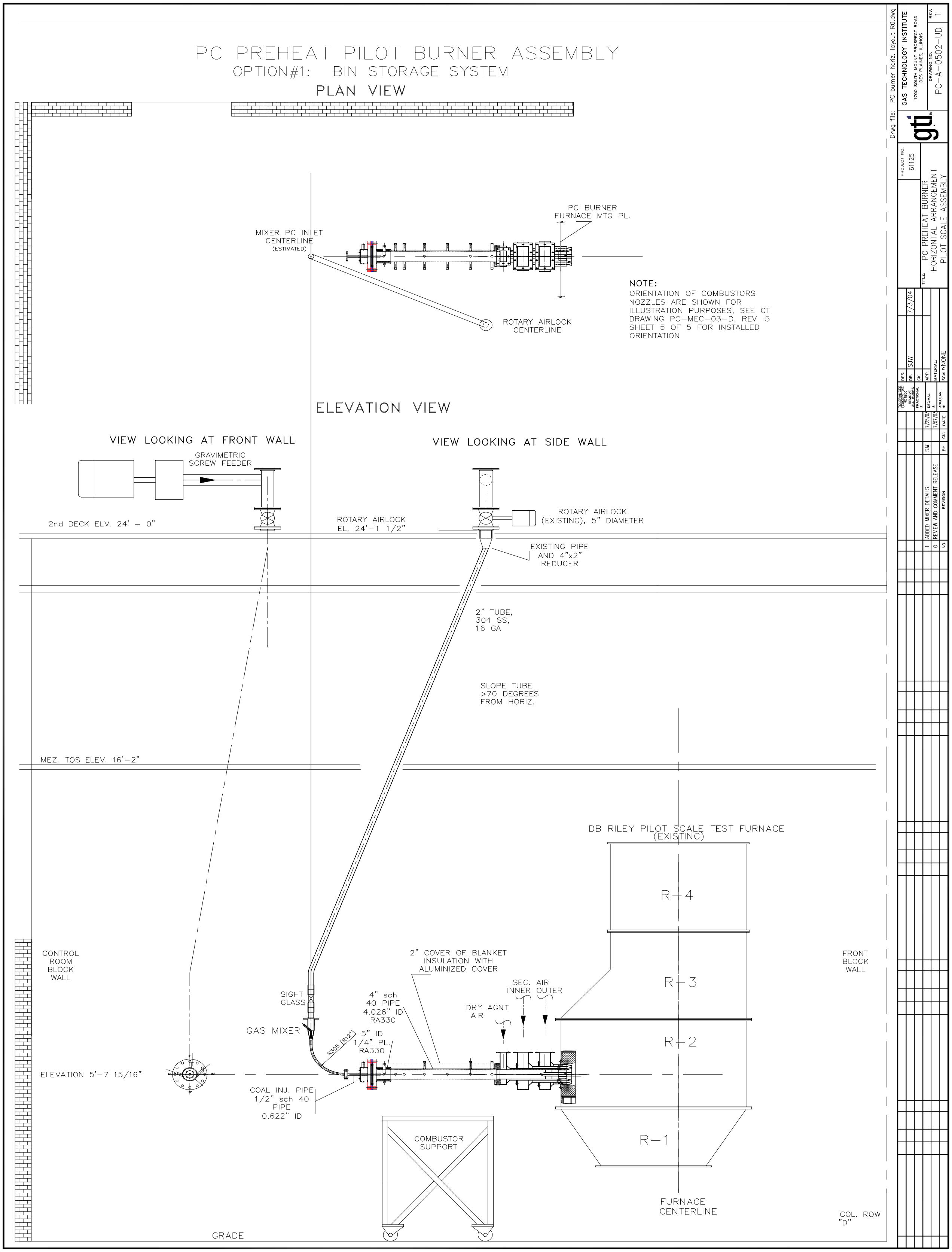

Figure 3. General arrangement for the horizontal PREHEAT combustor and associated components.

Task 1.2 *CFD Modeling*

Pilot Unit

Additional 3-D modeling was completed for the horizontal PC PREHEAT pilot combustor arrangement at two gas/air nozzle inlet velocities, 102 ft/s and 148 ft/s, to evaluate the impact of the new configuration on combustor volatile matter release and temperature, density and velocity profiles. The objective of this evaluation was to determine a suitable length for the modified combustor to allow sufficient residence time for devolatilization.

Comparisons of gas phase temperature and density at various distances from the gas inlet nozzles along the combustor centerline for the two gas inlet velocities are shown in Figures 4 and 5. It can be seen from these figures that for both inlet gas velocities, the temperature and gas phase density are essentially stabilized at about 40-inches from the combustor inlet, indicating that devolatilization is complete at this point. Based on this, the horizontal PREHEAT pilot combustor length was set at 40-inches.

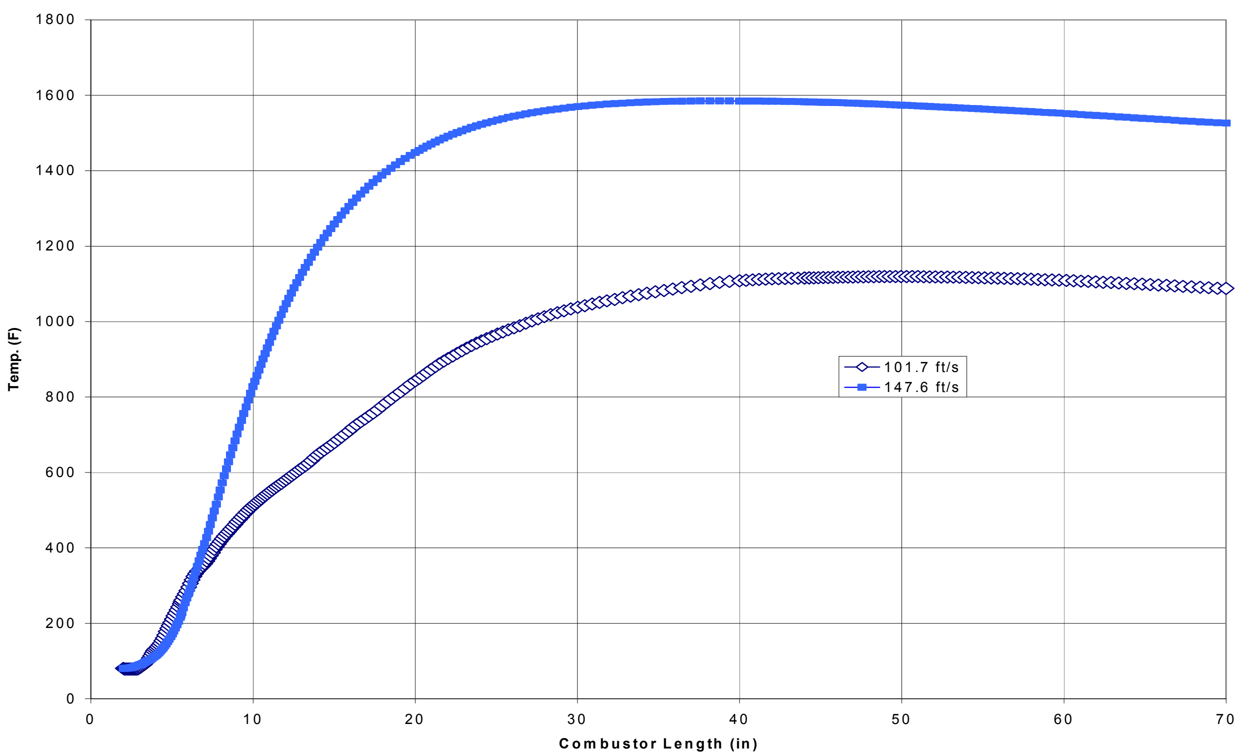

Figure 4. Temperature at the combustor centerline for two inlet gas velocities

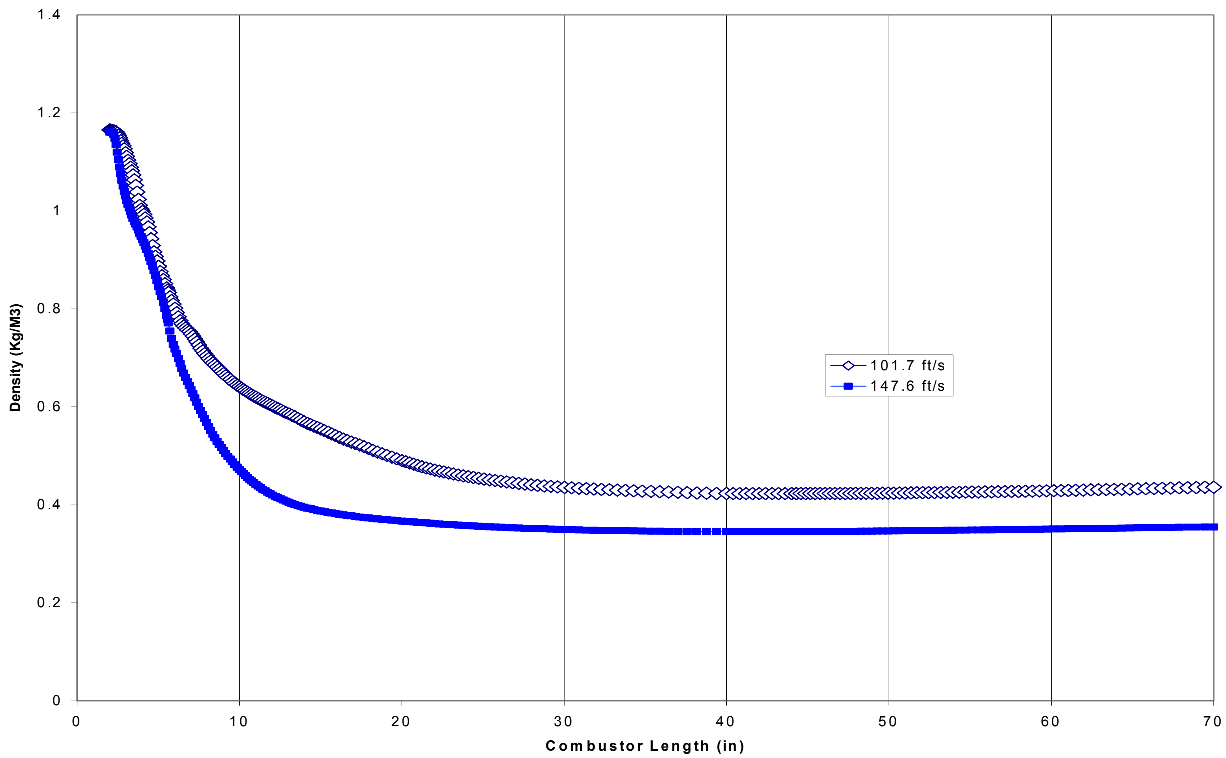

Figure 5. Gas phase density at the combustor centerline for two inlet gas velocities

100 MMBtu/h Unit

Modeling in support of the 100MMBtu/h design was initiated during the quarter. The approach used was to have RPI perform 2-D axisymmetric aerodynamic CFD simulations without combustion to fix the major parameters of the burner design while GTI conducted 3-D simulations with combustion for the PREHEAT combustor. The output of the combustor simulations will then be used as input to the burner simulation to simulate and evaluate the overall system.

For the initial 2-D modeling, GTI provided typical properties of the pyrolysis products entering the burner as fuel based on 3 MMBtu/h pilot testing experience. The degree of devolatilization of the feed coal within the combustor was set at 70% for the simulation. Due to limitations in the CBTF coal mill capacity with PRB coal, the maximum firing case for the burner was determined to be 85 MM Btu/h.

The design basis coal analyses for Central Appalachian and PRB coals were set. The basic burner configuration approach for the 100 MM Btu/h design was also set, including primary, secondary and tertiary air streams, the tertiary to secondary air ratio, the use of swirl in the air streams, the use of a Venturi and toothed ring in the coal tube, velocities in the coal tube (including turndown operation), the range of possible burner quarl and air diverter angles, and a fixed excess air concentration of 15%.

In order to maintain a low oxygen concentration in the PREHEAT combustor, the primary air stream will be separated from the pulverized coal using an existing cyclone in the CBTF just upstream of the combustor inlet. This air will then be routed to a third air channel between the burner coal tube and the secondary air channel. This primary air arrangement was incorporated into the burner preliminary design and modeling.

Using the above burner design criteria, RPI prepared burner design and record sheets for the 100 MMBtu/h Coal Burner for both Central Appalachian and PRB coal based on their CCV DAZ (CCV Dual Air Zone) design approach. It was determined that in order to maintain the coal tube velocity within recommended ranges, two different coal tube diameters are required for these coals. The initial 2-D aerodynamics CFD simulations for PRB and Central Appalachian (CA) coal were performed using typical combustion product flows and temperatures based on RPI's modeling and testing results with about 10 different coals. A circular tunnel furnace with a diameter of 17 feet was used in the simulation, matching the CBTF furnace cross-section area. Some of the initial CFD results are shown as contour plots of axial velocity (ft/s) for PRB coal (Figure 6) and CA coal (Figure 7). In these plots, negative axial velocity regions are shown as white areas indicating the extent of internal recirculation zones. Both the PRB and CA coal burners were found to produce similar near burner aerodynamics, creating an internal recirculation zone (IRZ) with an axial length comparable to the burner discharge diameter. The near burner aerodynamics indicated an attached tubular flame.

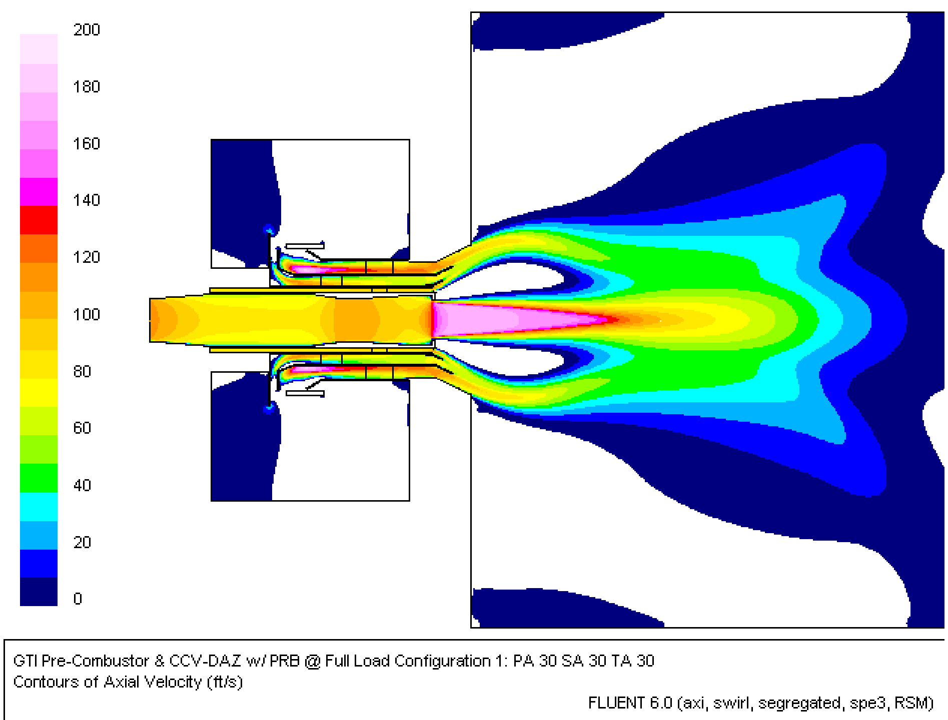

Figure 6. CFD Results on Near Burner Aerodynamics with PRB Coal Firing, Axial Velocity Contour

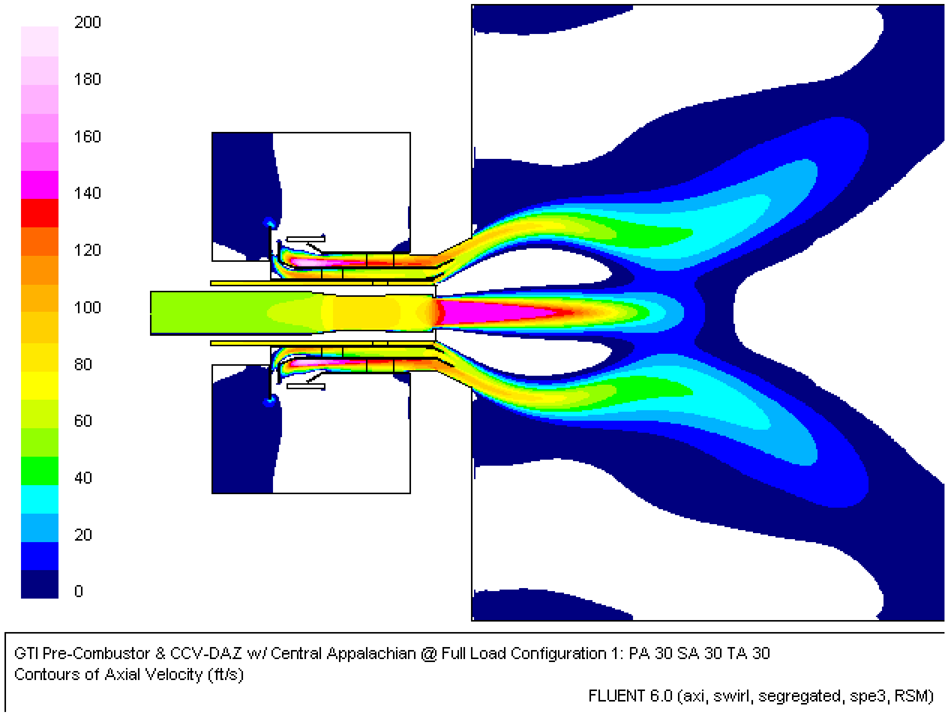

Figure 7. CFD Results on Near Burner Aerodynamics with CA Coal Firing, Axial Velocity Contour

RPI's CCV® DAZ burner typically produces two distinct internal recirculation zones close to the burner discharge with an axial length on the order of two burner throat diameters. Figures 6 and 7, however, indicate a single, relatively weak recirculation zone with the initial burner design. The CFD simulations were therefore continued in order to a achieve near burner flow field similar to that which CCV burner experience indicated would result in low NOx emissions. Various burner operational and geometry changes were investigated including:

- Flame stabilizer flow area
- Tertiary swirl vane angle
- Secondary Air (SA) / Tertiary Air (TA) flow rate ratio
- Burner quarl, SA and TA flow diverter angles

The CFD simulation results for the optimized burner design is shown in Figures 8 and 9 as plots of Stream Function (lbm/s) for PRB and CA coals, respectively. This burner arrangement produces an acceptable CCV-like near burner flow field with two distinct internal recirculation zones close to the burner discharge. This arrangement was therefore accepted as the design basis for detailed design and drafting effort for the 100MMBtu/h burner. Detailed hardware specifications were then developed to guide the designers in drawing development and fabrication for both the PRB and CA versions of the burner. It was further decided that the test burner will include adjustable swirl vanes in all three air channels to facilitate burner testing and optimization.

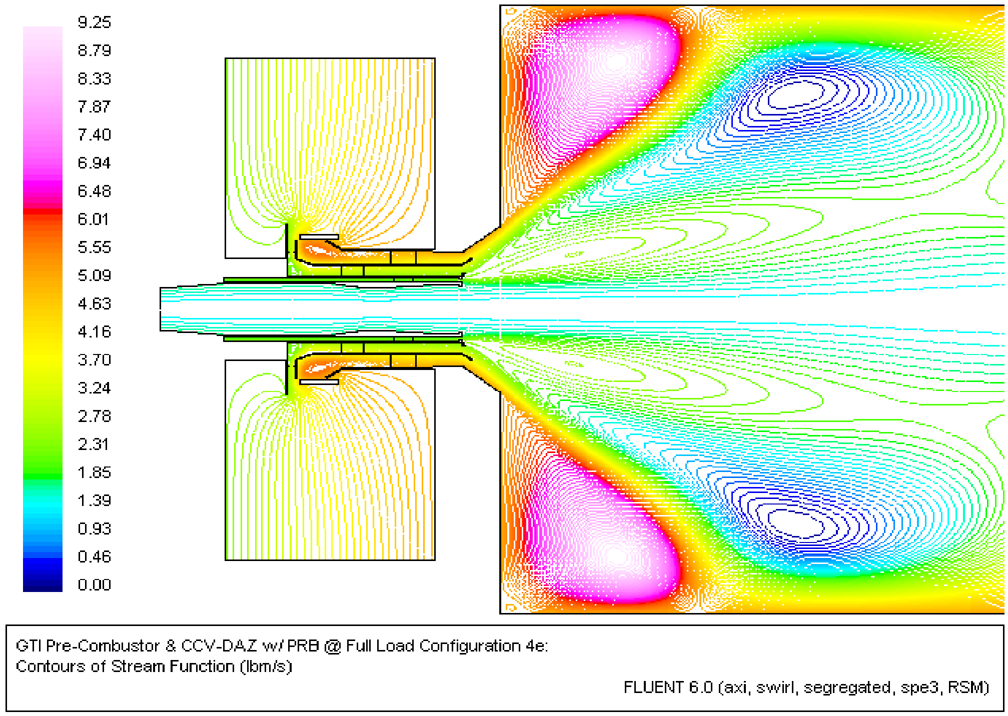

Figure 8. CFD Results on Near Burner Aerodynamics with PRB Coal Firing, Stream Function (lbm/s)

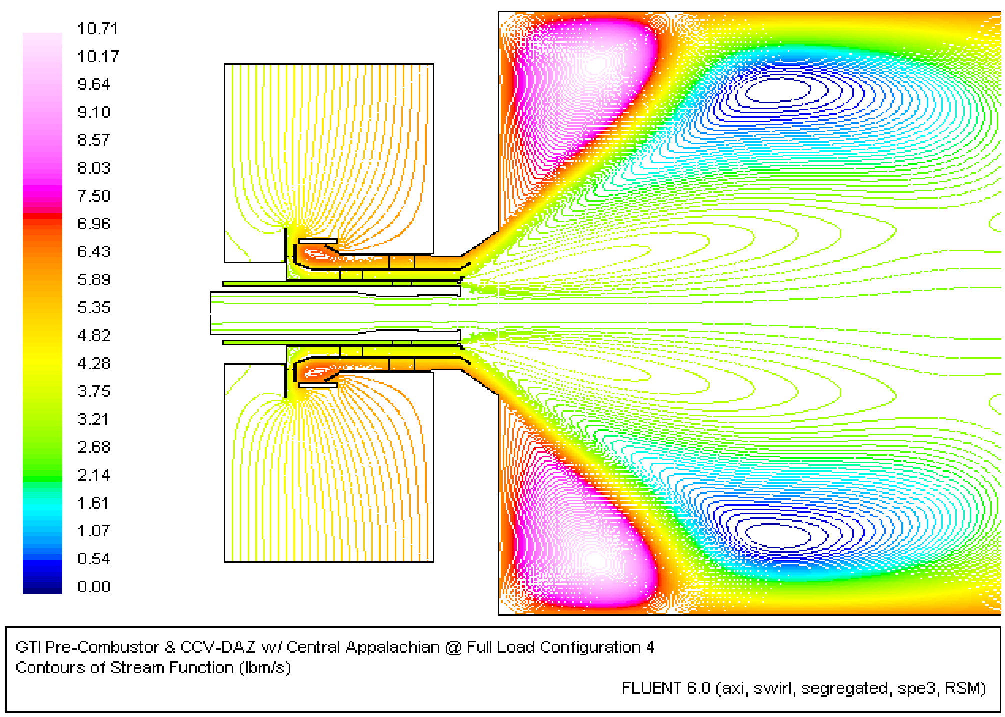

Figure 9. CFD Results on Near Burner Aerodynamics with CA Coal Firing, Stream Function (lbm/s)

With the burner design basis established, CFD modeling (3-D with combustion) with PRB coal was started in support of the 100 MMBtu/h design. Modeling studies focused on the size and position of the natural gas/air nozzles with respect to the central coal pipe. Design variables evaluated included coal feed pipe size and location, and the number, size and radial location of the gas nozzles relative to the coal pipe. In addition, two preheat combustor diameters were modeled. The effect on temperature, velocity magnitude and volatile matter release along the combustor centerline was evaluated. A comparison of the mass flow of volatile matter along the combustor centerline for the various configurations evaluated is shown in Figure 10. The results indicate that the larger diameter combustor (Approach 6) is preferred. In addition to releasing more volatile matter at a shorter distance from the combustor inlet (shorter combustor required), the larger diameter increases the coal residence time in the hot zone of the combustor by 2.5 times. Based on these results, design and fabrication drawings for the PRB version of the PC PREHEAT are currently being developed.

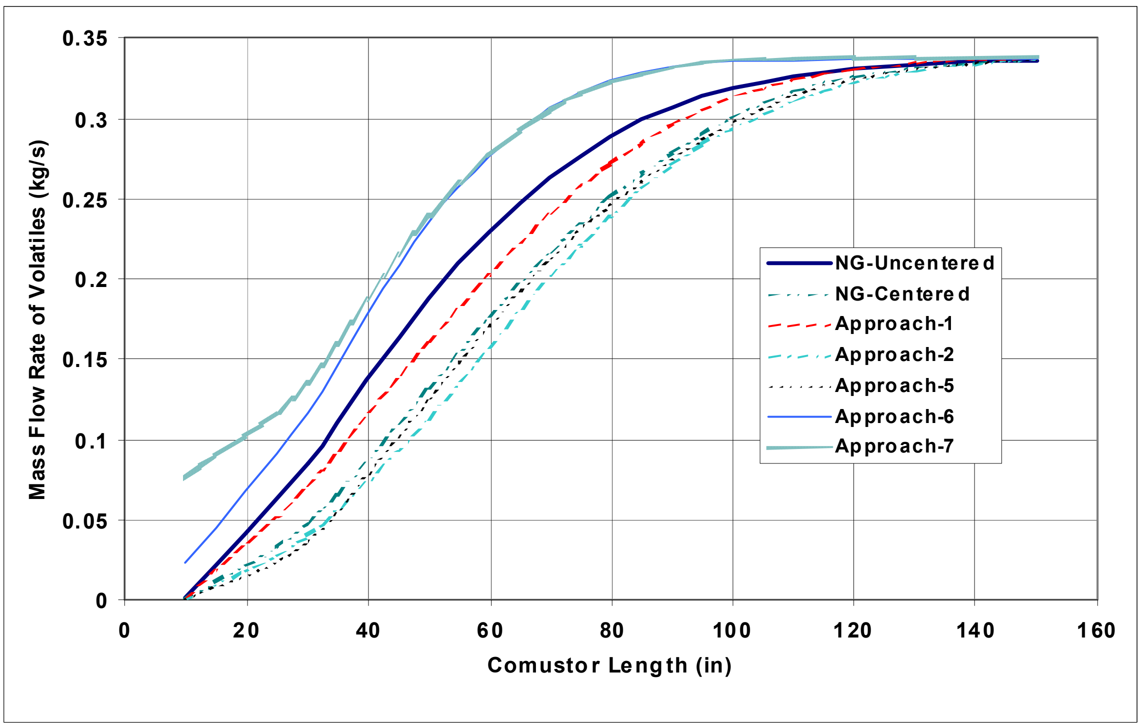

Fig. 10 Distribution of the mass flow rate of volatiles along the preheater centerline for the 100MMBtu/h PRB coal case.

3-D CFD modeling of the combustor for the CA coal case will be started once the most favorable configuration to avoid plugging of the combustor with caked material is identified. Pilot-scale testing was continued CA coal in the 3 MMBtu/h unit during the quarter for this purpose. The results of this testing are discussed under Task 1.4 below.

Task 1.3 *Pilot-Scale Equipment Fabrication and Installation*

All installation work was completed to relocate the pilot gas combustor to a horizontal orientation along the centerline of coal burner. The relocated PREHEAT combustor and associated piping and instrumentation are shown in Figure 11. Other pilot design changes to accommodate caking coal included a reduction in the combustor diameter to match the coal burner and an increase in the combustor length. This increased the combustor velocity and eliminated the diameter reduction at the combustor outlet that has been a source of plugging with caking coal, while slightly increasing the residence time for char and devolatilization products within the combustor. All combustor natural gas and air piping and controls were relocated to grade level near the combustor for convenience in operating the unit. The 2-in diameter coal feed pipe was lengthened to accommodate the new combustor location and the coal gas mixer was relocated just above the combustor. The transition from the vertical coal feed pipe to the horizontal combustor coal inlet was accomplished using a long-radius bend after the mixer.

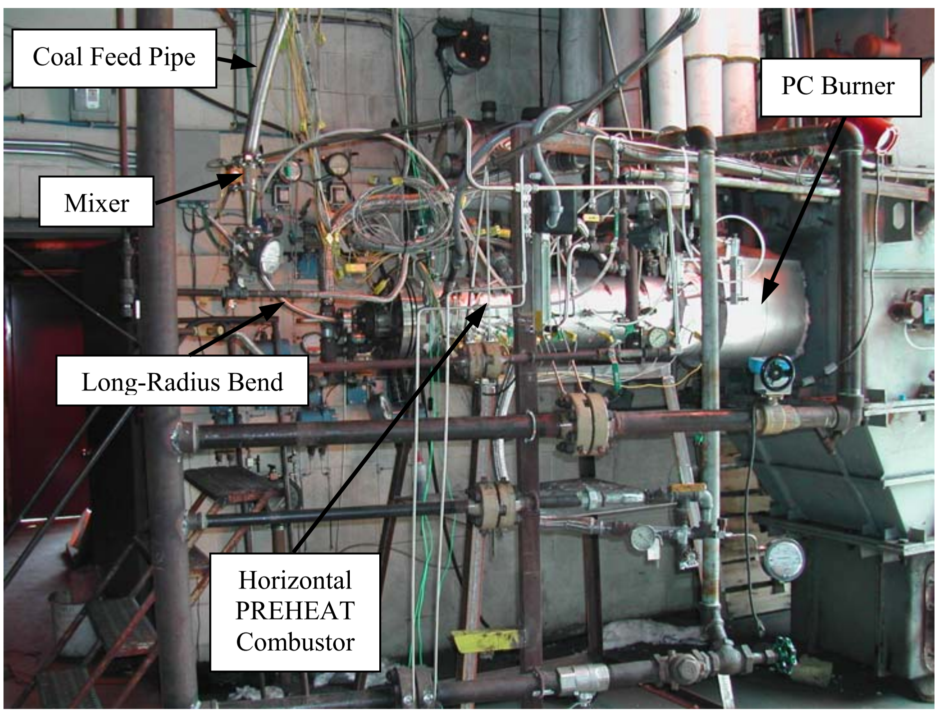

Figure 11. Horizontal Pilot PREHEAT Combustor

Task 1.4 *Pilot-Scale Testing*

Pilot system checkout, instrument calibration and preliminary natural gas test firing were completed during the week of August 11. All instruments were checked for proper installation and documented, including placement of skin and internal thermocouples. All pressure transducers were calibrated and thermocouples checked for correct input type to the data acquisition system (DAS). The modified DAS screens were checked for proper configuration and to insure that screen readings matched field readings. Dimensions of the modified combustor and burner were checked and confirmed. Purge lines to the inspection ports and flame sensors were installed and tested. A vibrator was installed on the extended coal feed line ahead of the combustor. Air and gas lines were pressure tested for leaks. The combustor pilot and main flames were tested for pulse-free operation and strong visible flames. The pilot and main flame were shutdown and restarted several times to insure consistent operation. The system was then fired to an internal temperature of 1800ºF to check for any thermal expansion problems.

The following week, a series of quick scoping tests were conducted CA coal to determine the most favorable operating approaches to avoid plugging and coal particle agglomeration in the modified horizontal combustor. The first 2 tests were conducted with PRB coal, which confirmed that the combustion and emissions performance of the horizontal combustor was similar to that achieved with the vertical combustor. Tests were then conducted with Central Appalachian caking coal to evaluate the effect of various operating regimes on caking in the combustor. Three different combustor internal diameters (ID) were tested by using various inserts in the combustor housing. Settling out of the coal is a concern in the horizontal combustor as opposed to the vertical combustor where it was not an issue. Tests were therefore conducted at 3 velocities in the horizontal combustor ranging from 53 ft/s to 96 ft/s at each combustor ID, significantly higher than the 30-40 ft/s tested with the vertical combustor orientation. While continuous operation had been achieved with caking coal only up to 50 lb/h with the vertical unit, continuous operation at 126 lb/h was achieved with the modified horizontal unit at the higher velocities. Some deposition of caked material was still observed on the combustor walls, however, and agglomerated char particles were observed exiting the burner into the furnace. This will have a negative impact on LOI. It was noted in these tests, however, that caking on the wall of the combustor occurred only in a discreet range of distance from the combustor inlet, with no deposition at all either before or after this region.

Due to the scoping nature of these tests, operating conditions were selected to evaluate impact on caking rather than combustion or emissions performance and steady-state operating periods were therefore not defined. All operational data including flue gas analyses were recorded as usual to aid in the evaluation. While not measured under steady-state operating conditions, NOx results with bituminous coal were promising none-the-less, with readings in the range of 150 ppmv at 4% O_2 in the exit gas. NOx results for test conducted with a 3-in ID ceramic insert in the combustor are shown as a function of furnace exit oxygen in Figure 12. Further pilot testing is planned to minimize particle agglomeration and increase operation with caking coal to the full 150-lb/h design value.

Based on the results of the scoping tests, a number of strategies were developed to improve operation of the 3 MMBtu/h pilot system with caking coal. The objective for these strategies is to achieve continuous operation of the pilot system at its design coal feed rate of 156 lb/h, without plugging or agglomeration of the pulverized coal. The following modifications to the pilot system were defined for operation with Central Appalachian caking coal:

- Modification of the mixer air/N_2 injection pipe to avoid the potential for "clumping" of the pulverized coal prior to entering the Preheat combustor.
- Introduction of natural gas in the mixer instead of air or N_2 to preheat the coal (and pass through the sticky phase) more rapidly in the combustor.
- Lengthening the coal pipe inside the combustor to slow the preheating and to shorten the residence time of preheated coal in the combustor.

- Installation of a Venturi insert at the end of the coal pipe to force the combustion gases and coal/char together in the center of the pipe for improved mixing/heating and to keep solids away from the combustor walls.
- Modification of combustion air distribution in the gas combustor.

Drawings of the required components and modifications were forwarded to RPI for fabrication in preparation for additional pilot testing in early October.

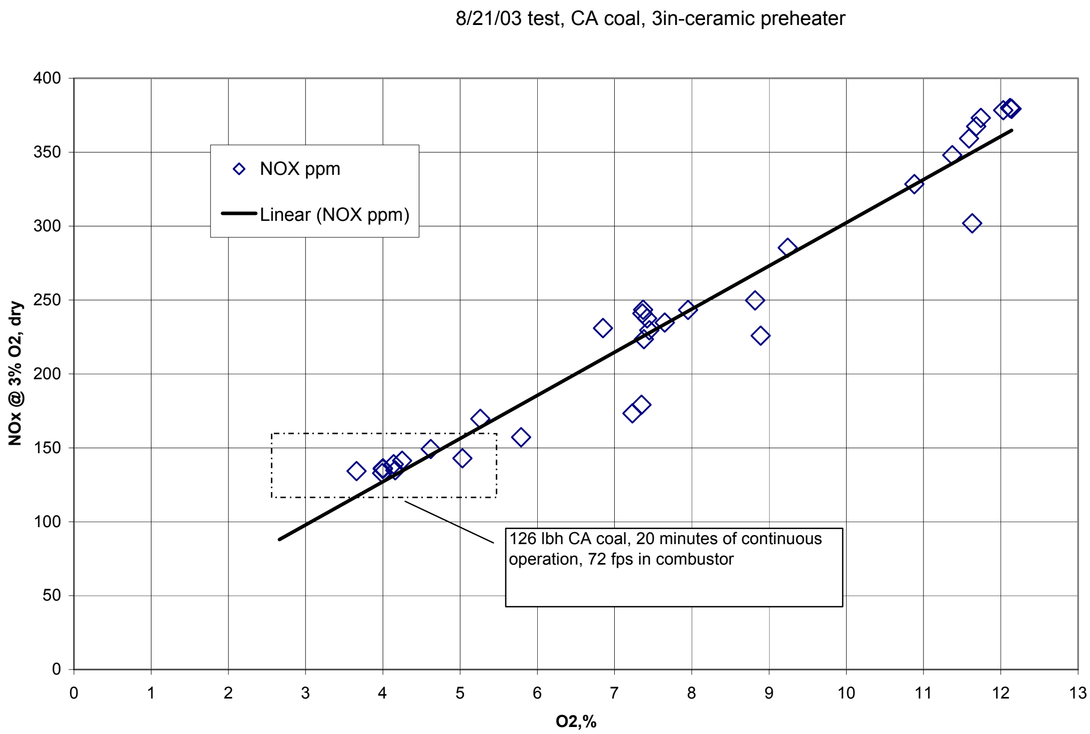

Figure 12. NOx results as a function of furnace exit oxygen for test conducted with a 3-in ID ceramic insert in the combustor.

Task 1.5 *Pilot-Scale Data Evaluation*

Data evaluation for the original pilot-scale system is complete. The data evaluation for the modified pilot-scale system in support of operation with caking coal is ongoing.

Task 2.1 Commercial Prototype Engineering Design

Development of the commercial prototype burner design was continued by GTI with collaboration from RPI and VTI. Based on the 100 MMBtu/h unit CFD modeling work discussed above, hardware specification details for the test burner configurations for both PRB and Central Appalachian coals were developed by RPI specific to the CBTF. The specifications include all burner critical dimensions, quarl and diverter angles, and internals including swirl vane locations and angles. All swirl vanes in the test burner are specified as adjustable.

A preliminary layout for the 100 MMBtu/h unit was developed, reviewed and modified to straighten the coal transport pipe inlet to the cyclone. General arrangements were defined for the combustor, thermal expansion compensator, gas mixer and a spool piece to compensate for the difference in combustor lengths between the PRB and CA coal PREHEAT combustors. Temperature ranges for the burner fuel and air channels were established to facilitate selection of their materials of construction. Design details and process flows were established for 4 tertiary air ports around the burner throat for possible future testing with air ports rather than a channel. Modifications to the PC burner ignitor support tube were developed to minimize interference with airflow and spin. The spark rod and gas gun centerlines were positioned relative to the burner centerline. A design for the surrounding support structure was developed to facilitate removal and replacement of both the burner and PREHEAT combustor.

A full time draftsman was assigned to the project by RPI for development of the 100MMBtu systems. A scheduler was also assigned and a draft schedule developed. GTI's target to begin testing with PRB is early to mid-December. It is doubtful that testing can be conducted during January and February due to concerns about freeze damage to the water-cooled CBTF. The December starting target is very aggressive considering the amount of design, fabrication and installation work yet to be completed. However, GTI and RPI have agreed to proceed as rapidly as possible to try to get at least some test work in before freezing weather.

Task 2.2 Baseline Data Review

RPI continues to and review combustion and emissions test results obtained with their commercial CCV burners for a variety of coals, including bituminous and non-bituminous coals from both the CBTF and field-testing programs. This analysis is being used to guide the commercial burner development in the CBTF such that the resulting burner will perform satisfactorily in actual field applications.

Task 2.3 Commercial Prototype Construction

As of mid-September inspection and repairs to the 100 MMBtu/h CBTF test facility were approximately 95% complete. The only remaining work is the inspection and re-certification of the caustic tank.

Task 2.4 Commercial Prototype Testing

No work was performed on this task during the reporting period.

Task 2.5 Data Processing and Evaluation

No work was performed on this task during the reporting period.

Task 2.6 Commercialization Plan Development

No work was performed on this task during the reporting period.

Task 2.7 Design and Fabrication of Commercial Burner System

GTI received a call from NIPSCO (Northern Indiana Public Service Corporation) regarding a possible PC PREHEAT commercial-scale burner demonstration in their Dean H. Mitchell Station in near the U.S. Steel Works in Gary, Indiana. A meeting was arranged at Mitchell

Station to discuss the possibility of a demonstration at plant. Attending from NIPSCO were Robert Cook, Manager-Major Projects, Mark Small, Manager-Michigan City Station, and Philip Pack, Manager-Compliance Projects. In addition to GTI personnel, Bill Howarth, our 100 MMBtu burner project manager from BPI attended.

The candidate boiler at Mitchell is a 115 MW B&W boiler with 4 pulverizers feeding 12 burners in 4 rows of 3 burners each. The unit was installed in the early 70's, is somewhat fan-restricted and burns 8600-9000 Btu/lb PRB from Southern Mines. The permit limit for the boiler is 0.5 lb/MMBtu and it runs at about 0.23 lb/MMBtu. Reducing NOx on this unit is therefore not a priority. Due to its relatively small size, reducing NOx on this boiler would not have a major impact on NIPSCO overall NOx emissions. NIPSCO would be willing to participate as a host site depending on cost and other factors. There is a 500 MW unit at Schaefer that currently has 24 low-NOx burners and also burns pure PRB at about 0.2 lb NOx/MMBtu. If the demonstration at Mitchell is successful, application of the technology at Schaefer could have a major impact on NIPSCO's system-wide NOx emissions.

The units at Mitchell as expected to start coming on-line in late 2004-early 2005, which is a good timeframe for the demo. It was agreed that GTI would keep NIPSCO informed on progress with the 100MMBtu/h testing at RPI. In the meantime, we will get a confidentiality agreement in place. GTI will investigate potential funding sources for the demo and submit a proposal to NIPSCO for the demonstration following successful 100 MMBtu tests with PRB.

Tasks 1.6 &2.8 Management and Reporting

A fourth modification (M004) to RPI's subcontract was initiated to increase their spending limit to the full subcontract value.

A presentation summary was submitted for the project to be presented at DOE/NETL's 2003 Conference on Selective Catalytic and Non-Catalytic Reduction for NO_x Control, to be held October 29 and 30 in Pittsburgh.

A proposal was submitted to GTI's SMP program to fund the balance ($75,000) of their $150,000 cost share commitment for the project.

Plans for Next Quarter:

- Present project results at the 2003 DOE/NETL SCR/SNCR conference in Pittsburgh.
- Complete pilot testing with caking coals in the horizontal combustor configuration.
- Continue pilot data evaluation and modeling as required.
- Complete the Task 1 Topical Report for Pilot-Scale testing.
- Complete the 100 MMBtu/h unit design for caking coal.
- Complete reactivation of the 100 MMBtu/h Coal Burner Test Facility (CBTF) and design and installation of the 100 MMBtu/h PC Preheat system.
- Initiate 100 MMBtu/h testing with PRB coal

CONCLUSIONS

The primary focus for the project continues to be on developing a PC PREHEAT system design suitable for use with caking coals and readying the 100 MMBtu/h CBTF for testing.

The transition to a horizontal PREHEAT combustor orientation in the pilot unit has been successfully completed and initial testing has shown potential for improved performance with caking coals.

The design for the 100 MMBtu/h unit for testing in the CBTF was significantly advanced during the quarter, and testing with PRB coal is targeted to start in early- to mid-December. GTI and RPI have agreed to proceed as rapidly as possible to try to get at least some test work in before freezing weather prohibits testing.

The availability of the pilot and 100 MMBtu/h test facilities is expected to provide a unique experimental resource for future studies of the effect of pulverized coal pretreatment via devolatilization and pyrolysis as a basis for control strategies for a variety of emissions, either alone or in combination with other strategies such as coal blending, including mercury, SO_2 and particulate as well as NOx. Considering NOx control alone, PC PREHEAT in conjunction with other control technologies such as overfire air may be expected to achieve NOx reduction similar to long-term average reductions with SCR, which are in the range of 80%[1]. PC PREHEAT can also be expected to have a market even in those plants that have already installed SCR or SNCR, since combustion-based NOx reduction can significantly reduce costs associated with SCR reagent and catalyst replacement providing a lower overall operating cost than SCR or SNCR alone.

REFERENCES

1. Krishnan, Ravi., "For NOx Control, Try a Layered Approach," Chemical Engineering, October 2003, p. 85

Milestone Status Table: The planned completion dates for all project tasks and major milestones are currently be revised.

ID No.	Task / Milestone Description	Planned Completion	Actual Completion	Comments
♦	Kickoff Meeting	5/2/2000	5/2/2000	Complete
1.0	Technology Development			
1.1	Pilot-Scale Design	8/31/2000	12/31/2000	Complete
1.2	CFD Modeling-Pilot and Commercial Scale	6/30/2001		Modeling modified pilot-scale combustor and burner complete
1.3	Pilot-Scale Equipment Fabrication and Installation	11/30/2000	9/30/2001	Modified gas combustor & burner installation complete
1.4	Pilot-Scale Testing	3/31/2001		Completion expected 12/2003
1.5	Pilot-Scale Data Evaluation	4/30/2001		Completion expected 12/2003
1.6	Task 1 Management and Reporting	4/30/2001		Completion expected 12/2003
♦	Task 1 Report	4/30/2001		Completion expected 12/2003
2.0	Technology Validation			
2.1	Commercial Prototype Engineering Design	7/31/2001		Completion expected 11/2003
2.2	Baseline Data Review	7/31/2001		Completion expected 11/2003
2.3	Commercial Prototype Construction	10/31/2001		Completion expected 12/2003
2.4	Commercial Prototype Testing	2/15/2002		Expected to start 12/2003
2.5	Data Processing and Evaluation	3/31/2002		*
2.6	Commercialization Plan Development	6/15/2002		*
2.7	Design and Fabrication of Commercial Burner System	7/31/2002		*
2.8	Task 2 Management and Reporting	8/10/2002		*
♦	Final Report	8/10/2002		*

*May extend beyond the current contract end date due to the inability to run the 100 MMBtu/h unit during freezing weather in January and February.